

Science Policy, Urban Development and Technopoles

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Technopoles, the concentration of science, technology and innovation capabilities in some areas, are all the rage today in science and technology policy. What makes the Silicon Valley to be what it is? Or, more cogently: is it possible to create new Silicon Valleys, which seem to have emerged spontaneously, by purposeful action, by design?

There is a clear parallel between the relatively new discovery of technopoles and their importance for scientific and technological development today and a much older question about the ways to develop countries or regions. A common idea, in the past, was that development could be stimulated by the concentration of resources in a big project, which could generate employment, spread wealth and spur other initiatives. In the United States during the depression years, the Tennessee Valley Authority embodied this spirit, and there was an attempt to replicate the idea in Brazil in the sixties through the industrial investments of the Development Agency for the Northeast, SUDENE.¹ The parallel, in science and technology, were the "big science" projects in the United States, from the space program to the super-collider, and their equivalents in Brazil, the Nuclear Program, the Space Mission Program or the Nuclear Submarine.

The tendency, today, is to look at these ambitious initiatives with skepticism, and to examine successful histories from the perspective of much more tenuous explanations, based on what is being called "social capital," the fabric upon which the web of human creativity and innovative competence can develop.²

My presentation will expand on this new perspective, trying to see what it means in terms of science policy from the standpoint of a scientifically small country such as Brazil.

The key observation concerning urban development, which challenged the traditional emphasis on large-scale investment, was that economic growth required many independent agents seeking to maximize their earnings and to improve their living conditions, which could not be replaced by a single, centralized bureaucracy or organization. The introduction of one or a few large, modern industrial projects in backward regions led often to the disruption of traditional life styles and their underlying social fabric, without replacing them with a modern, dynamic and creative social environment. Skilled labor had to be brought from afar and placed in protected enclaves surrounded by shanty towns, or replaced by labor-saving

¹A central element in the TVA approach was the attempt to involve the local population in its planning activities, an approach that SUDENE never tried to implement. Even so, the record of TVA is controversial. See, among others, Phillip Zelnick, *TVA and the Grass Roots*, Berkeley, 1949; and Steven N. Neuse, "TVA at Fifty: Reflections and Retrospect", *Public Administration Review* 43, 6, November-December 1983, 491-499. SUDENE was created in 1959, and placed under the leadership of Celso Furtado. See, among others, Celso Furtado, *A Operação Nordeste*, Rio de Janeiro, Instituto Superior de Estudos Brasileiros, 1959; Albert O. Hirschman, *Journeys toward progress; studies of economic policy-making in Latin America.*, New York, Twentieth Century Fund, 1963; Amélia Cohn, *Crise Regional e Planejamento: o processo de criação da SUDENE*, São Paulo, Perspectiva, 1976; Francisco de Oliveira, *Elegia para Uma re(li)gião: SUDENE, Nordeste: Planejamento e conflito de classes*, Rio de Janeiro, Paz e Terra, 1977.

²The expression may be new, but the issue is classic in the social sciences, being as it was at the center of Max Weber's work on the origins of modern capitalism and rationality. See, for a recent example, Jane E. Fountain, "Social Capital: A Key Enabler of Innovation", in Lewis Branscomb and James Keller, *Investing in Innovation*, MIT, 1998.

technologies; supplies had to travel a long way, and products sold to distant markets. Most of the surplus generated by these investments went back to the centers from where the capital and skilled labor had originated, and whatever remained in the region was treated by the few local beneficiaries as rents, not depending on industriousness and entrepreneurship to be nurtured and to growth. Effective and long-lasting development required, not a population of rent seekers fed by a large source of income and benefits, but strongly motivated individuals, striving to improve their and their children's skills, and engaged in all kinds of small projects and initiatives. Large projects could later develop from this foundation, and the successful experiences where those that did not absorb or destroy the large webs of small initiatives, but could be added to and combined with them.

The next question was to explain why these webs of individual initiative and motivation emerged in some places and regions but not in others. The traditional psychological or cultural explanation was that persons in some social groups have an ingrained drive and motivation for achievement, while others, living in different societies and cultures, did not. Protestant, European Jews, Japanese, Northern Italians and Hungarians seem to belong to the first group: Catholics, Southern Italians, Frenchmen, Indians, Latin Americans, and Blacks in the US seemed to belong to the latter. Was it something in their genes? In their religion? In the way their families and broader social networks are organized? Max Weber's answer seems still to be the best. For him, there was something ingrained in the Jewish - Christian tradition, a cultural and normative value stressing individual achievement and rationality, in contrast to other traditions - the Confucian, in China, and the Indian religions - which placed emphasis on contemplation, the cult of the ancestors and the acceptance of received wisdom. Weber's brilliant contribution was to associate these value differences with the ways societies were organized. In the old Jewish tradition, he identified a society without a state, centered on the strength of individual initiatives and communal solidarity; in the Oriental tradition, there were powerful patrimonial states, based on military strength, religious hierarchies or large-scale irrigation works. These differences between traditions of strong and weak social hierarchies are used to explain why the values of individual achievement developed less in the Catholic Christendom than among Protestants, and more in modern societies that emerged from a feudal past - Western Europe, Japan - than in those that grew from the decay of centralized Empires - Latin America, Russia, Turkey.

Individual initiative and creativity, however, require interchange and cooperation to generate social benefits. Markets can only grow in the presence of common rules of the game and shared assumptions. They are necessary to compete, and still more necessary to develop the large and complex organizations that are typical of modern societies, Émile Durkheim, at the turn of the century³, argued that one could not have division of labor, *solidarité organique*, without a common basis of identity and values, *solidarité mécanique*. Francis Fukuyama, in his recent book on *Trust*⁴, explains the economic achievements of Japanese and American societies, in contrast with the Chinese and the French, in terms of the former's ability to go beyond the boundaries of family loyalty and reach out to large networks of sociability and trust. Max Weber, in his earlier studies on the German stock exchange, pointed to the need of shared values as the condition for their operation. Two Polanyi's, Karl and Michael, developed parallel arguments regarding the role of social institutions and trust both in the economy and in scientific knowledge. Modern capitalism, argued Karl Polanyi⁵, was not just the result of individual initiative and competition, but required the building up of a very complex set of institutions, from the banking system to monetary authorities, and including a stable and predictable legal system. Scientific knowledge, argued Michael Polanyi⁶, developed on the assumption that truth does not emanate from established

³*La Division du Travail Social*, Paris, Presses Universitaires de France, 1967.

⁴Francis Fukuyama, *Trust - The Social Virtues and the creation of Prosperity*, New York, Free Press, 1995.

⁵Karl Polanyi, *The Great Transformation*, Boston: Beacon Press, [1985] c1944.

⁶Michael Polanyi, *Personal Knowledge*, London, Routledge and Kegan Paul, 1958.

authorities, but has to be checked and confirmed by each individual; in practice, however, modern science requires complex networks of trust, in which each participant can safely assume that his colleagues in another specializations and fields are as thorough and consistent in their work as himself. This network of trust and confidence is not spontaneous, but highly structured: science is organized in a hierarchy of prestige and recognition, with well-identified gatekeepers and mechanisms to recognize merit and bestow authority.

Three other elements are associated with trust and the institution of networks. The first is the tacit assumptions, or tacit knowledge, that underlies both the economic and the knowledge production activities. The second is the need for personal knowledge, physical proximity among the participants of the production networks. The third is what Robert K. Merton called the "Mathew's Effect" of accumulation, which economists of technology have rediscovered recently and called "path dependency."

To do business, or science,⁷ it is necessary to know how to behave, to distinguish what is appropriate and what is not, to identify the right path to follow, and to do all these things without having to think about them, or to learn them from a textbook. This kind of tacit knowledge is acquired through socialization, the continuous exposure to role models in the family, neighborhood, school and apprenticeship, from where these complex sets of attitudes and behavior are absorbed. Physical proximity and long time convivially are essential for the transmission of implicit knowledge and values, and for the construction of networks of trust upon which cooperative interchanges can grow. The enormous expansion of the means of communication in the last decades, from jet planes to teleconferencing and the Internet, led many to imagine that local ties could be replaced by global interchanges and contacts. What we witness, however, is not the disappearance of personal networks, but their extension and strengthening across wide geographical areas, and the persistence of physical proximity as a central component of successful entrepreneurial and scientific activities. It may just be that the new means of communication, instead of democratizing access and participation in previously closed networks, are leading to their further concentration and selectiveness. If I can find soul mates across the oceans, I do not have to relate with my neighbor of a different background, and I may end up moving my job and place of residence to live with my pack.

This situation is aggravated by the ways scientific and technological knowledge are produced in the end of this millennium. In the past, technical and professional competence depended strongly on the skills and practices acquired in well-structured academic disciplines or in the established professions. This, which Gibbons and others have called "mode I" of knowledge production, is being rapidly replaced by "mode II," characterized by transdisciplinarity, heterogeneity, pragmatic choices and blurred boundaries among basic, applied, academic or commercial work.⁸ It is much more difficult to operate in this kind of flexible and unstable environment than in the traditional disciplines and professions, with their established textbooks, educational paradigms and codes of behavior. There is no other way of learning this except by being there, and seeing how it is done every day.

The consequence of these trends is that what Robert Merton has called "the Mathew Effect" in science is getting more accentuated still.⁹ Easy mobility and communications

⁷Science and business may seem antithetic for purists, but in fact they are very similar in the way they function in competitive markets where personal initiative, entrepreneurship and accumulation of assets are essential. For a graphic illustration, see Bruno Latour, "Portrait d'un biologiste en capitaliste sauvage", *La Clef the Berlin*, Paris, La Découverte, 1993, 100-129.

⁸Michael Gibbons, Camille Limoges, Helga Nowotny, Simon Schwartzman, Peter Scot and Martin Trow, *The New Production of Knowledge - The dynamics of science and research in contemporary societies*, London, Sage Publications, 1994.

⁹Matthew 13:12: "Whoever has will be given more, and he will have an abundance. Whoever does not have, even what he has will be taken from him". Merton writes that the concept appeared "briefly and without elucidation in my 1942 paper on the normative structure of science" and "lay dormant in the sociology of science until it was reactivated a quarter-century later in 'The Matthew Effect in Science' ", a 1968 paper

make knowledge, competence, entrepreneurship and trust more cumulative than ever. As these values and assets pile up, what can be achieved tomorrow is strongly dependent - "path dependent" - upon what you have today. This is a major tenet of Michael Porter's celebrated *The Competitive Advantage of Nations*¹⁰; and the central policy recommendation coming from his study is that countries and regions should work upon their previous strengths - their comparative advantages - instead of trying to conquer new spaces and capabilities. Sensible as this recommendation might be, it reinforces the pattern of accumulation, and leaves countries and regions without previous knowledge and cultural assets in a very difficult position.

Jane E. Fountain, in her paper on the Silicon Valley, makes some suggestions of possible policies to build social capital. The buzzwords are cooperation, network, partnership. She examines two existing programs in the US, the Advanced Technology Program, for leading industries, and the Manufacturing Extension Partnership, for more traditional ones. The role of government should be to stimulate contacts, discussions, exchange of experiences - to increase personal contacts, interchange and the flow of implicit knowledge that already exists. Lewis Branscomb, in the conclusion of this book on "investing in innovation," defends, in addition, the need for a policy of innovation based on "six principles," which include broad support for basic technology and incentives to private innovation. He argues against the very large technology projects of the past, suggesting, instead, "to make numerous, smaller technology bets," following "the NSF/NIH model of relying primarily on relatively small grants spread out among many performers, awarded competitively but funded over multiple years."¹¹

The question faced by Branscomb and his collaborators was how to maintain and improve innovation in a country and regions that are already at the forefront of scientific and technological creativity, and are now faced with the uncertainties of a much more fluid and competitive environment, where the steady flow of resources stemming from the military establishments and the large, long term technological projects cannot be taken for granted any longer. Our problem, from almost the other extreme, is how to keep up and not to be left out completely from such an intense process of densification and accumulation of knowledge, competence and accumulation of wealth and opportunities.

We may not have a good answer to this question, or even an answer at all. But there are a few things we should try. One is to understand that our chances to succeed depend much more on our ability to participate fully in the networks of knowledge, information and personal ties of modern science and technology than on the development of specific projects in competition with more mature centers. This participation requires steady public support and initiative, because of the uncertain and long term benefits of such investments.¹² I argued above that these networks are less democratic and open than they seem, and are as dependent on personal ties and relations of trust as in the past; I also argued that they tend to pack in a

reprinted in R. K. Merton, *The Sociology of Science: Theoretical and empirical investigations*, Norman W. Storer (ed.), Chicago, University of Chicago Press, 1973. See footnote 35 in Merton, "The Sociology of Knowledge: An Episodic Memoir", in Merton and Gaston, editors, *The Sociology of Science in Europe*, the Southern Illinois University Press, 1977, p. 3-144.

¹⁰New York: Free Press, c1990.

¹¹Lewis A. Branscomb and James H. Keller, "Towards a Research and Innovation Policy", in Branscomb and Keller, editors, *Investing in Innovation - Creating a Research and Innovation Policy that Works*, MIT, 1998, p. 490.

¹² According to the summary of a recent World Bank conference on development economics, "the acquisition of knowledge and information is becoming increasingly critical to economic growth as scientific and engineering findings proliferate and take on ever-greater importance in the production of goods and services". Because of that, "the participants warned that recent moves away from publicly supported research and public dissemination of scientific findings are likely to be deleterious to most developing countries". *The World Bank Policy and Research Bulletin*, vol. 8, 4, October-December 1997, p. 2.

few places, the Technopoles. But it is also true that they are in principle open to whoever has the necessary skills and the language to join in the conversation. Technology innovation today takes place not only in very large institutions with multimillion dollar budgets and thousands of employees, but along a very large spectrum of sizes and investment capabilities, in extremely competitive conditions. This means that science and technology are, increasingly, a kind of commodity, to be sold and bought by those who have the skills to understand and to use them. This means also that high quality education, support for international cooperation and interchange, easy access to information and to advanced instrumentation are the essential foundations of any successful science policy. Good quality education is expensive, and likely to remain so; communications, access to information and use of sophisticated instruments are getting cheaper and more accessible each day, and can be used to spread the access and benefits of education as well.

The second lesson is that we need to stimulate, preserve and maintain places where skills and competence can come together, coalesce and develop the social fabric for innovation and entrepreneurship. This means that, even if we move away from big and expensive projects, we cannot avoid concentrating resources in some places and regions, more than in others. Life is not just work and competition. It is also enjoyment, conviviality and pleasant lifestyles. Successful Technopoles are those that combine, in the same region, good universities, easy access, good communications, and a pleasant urban and natural environment. There is nothing new on this idea, except that it seldom appears explicitly in the governments' statements and proposals for scientific and technological development. There is a good reason for that. Public policies are supposed to be equitable, but the development of high quality, socially dense and pleasant communities leads to the intensification of differences. One way to compensate for that is to decentralize, making the development of Technopoles as dependent as possible on local initiatives and resources. The other is to understand that the social benefits of investments in science and technology cannot be gauged by the way the investments are spread out, but by the way the benefits accruing from high quality and highly productive environments can be useful for all. It is a difficult path to thread, between equity and the concentration of benefits and privileges, without which, however, no successful science policy could succeed.

A final lesson is that institutions matter. Precisely because creativity and entrepreneurship are unpredictable, they require a stable environment of expectations and rules of the game to thrive and prosper. In part, institutions refer to people - the presence of reliable and trustworthy people making decisions in public institutions. In part, they refer to rules. A healthy environment should include well defined systems of grants and incentives, clear rules of intellectual property, and well defined mechanisms to place the proper persons in the right places.

If we have places with the proper environment, the proper institutions, mechanisms to acquire tacit knowledge and to reach out to the growing market of knowledge commodities, then there will have fertile grounds for larger and more ambitious projects; if not, the risks of wasting resources and energy are probably too high.